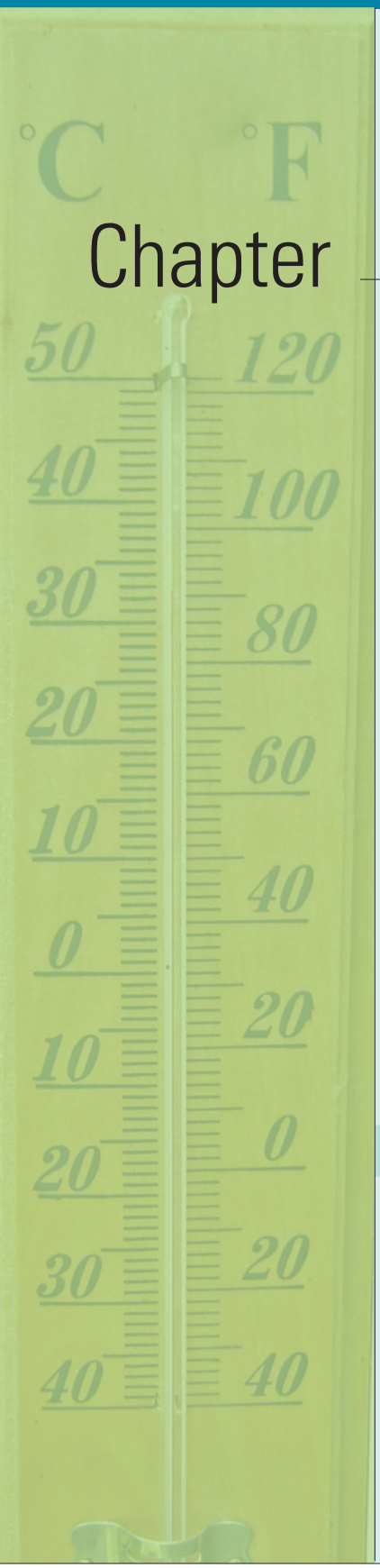



# Chapter 4

# Mass, Temperature, and Volume

## GOALS

In this chapter, you will consider temperature in the Celsius and Fahrenheit scales and measures of weight and mass in the Système internationale (SI) and imperial system. In the workplace and in everyday life, these measurements are applied in a variety of contexts, including cooking, medicine, farming, and building construction. In this chapter, you will build on your prior mathematical skills and knowledge to

- compare and make conversions within and between Celsius and Fahrenheit temperature scales and between imperial and SI units of mass/weight;
- examine the differences between mass and weight in each system; and
- perform other conversions that are important in the workplace, such as conversions between mass and volume.

## KEY TERMS

- Celsius (°C)
- conversion factor
- Fahrenheit (°F)
- gram (g)
- kilogram (kg)
- mass
- ounce (oz)
- pound (lb)
- temperature
- ton (tn)
- tonne (t)
- weight

## START TO PLAN

### PROJECT OVERVIEW

You may have seen cooking competitions on television where chefs challenge one another in the kitchen for fame and status. Can you think of some examples? In this chapter, you will plan a menu that could be submitted to an international cooking competition.

For this project, you will plan a menu consisting of an appetizer, main course, and dessert. You will also need to research all the recipes. Since this is an international competition, you must include ingredient amounts and cooking temperatures in both SI and imperial units. Finally, you will design a printed menu and a recipe booklet for submission and judging by your classmates.

*A la cuisine!**

*These competitors are preparing the final course of their gourmet meal.*

### GET STARTED

To begin your project, research recipes from different countries to see how they measure ingredients (by weight, by volume, or by both?). Next, plan your menu and find recipes for each dish. Decide on the number of guests you will feed. You will be assigned two ingredients that you must use. The rest is up to you.

You can either create your own recipes or use cookbooks, the internet, or other resources. When choosing your dishes and recipes, be sure to keep the following in mind:

- Do your dishes work together? Are they interesting and do they incorporate several ingredients? Do they incorporate the theme ingredients?
- You will convert the ingredients and temperatures in your recipes from SI units to imperial, or vice versa. Remember to choose either US or British imperial units, as applicable. Are your dishes complex enough based on this requirement? (The judges will be looking for evidence that you know how to communicate recipes to an international audience.)

### FINAL PRESENTATION CHECKLIST

You will present your menu and recipe booklet to your class and your teacher for evaluation. Each person in your class will vote, by secret ballot, for his or her top three favourites. Your final presentation must include the following:

- a menu with a brief description of each of the dishes; and
- a recipe booklet that includes
  - a recipe for each dish,
  - conversion tables for the various ingredients, and
  - a shopping list of all the ingredients with amounts converted into either SI or imperial units.

* *A la cuisine!* means "To the kitchen!" in French.

# 4.1 Temperature Conversions

## MATH *ON THE JOB*

Denise Sparrow, a citizen of the Musqueam First Nation, is the owner/operator of Salishan Catering in Vancouver, BC. In 1993, Denise began to package and sell salmon. Her business flourished and was transformed into a catering business that fuses traditional Musqueam cultural knowledge and foods with modern foods. Denise credits her success to her grandmother and her mother, who taught her the ways of her ancestors.

Denise's company offers many different kinds of catering services such as potlatch platters, family feasts, buffets, and full service six-course dinners for any number of people, sometimes with servers wearing traditional clothing. Denise also enjoys sharing her knowledge of traditional cultural food preparation with schools.

*Denise's catering company offers specialties like smoked salmon eggs on grilled bannock and pemmican buffalo jerky strips.*

Denise is planning a banquet for 400 people. She is serving appetizers of alder-smoked salmon, buffalo sausage, and BBQ bannock. The main course will include venison, seaweed, wild rice, sea asparagus, and a green salad. Wild berry and whipped soapberry dessert will finish off the meal. Denise is used to working in degrees Fahrenheit but the refrigerator and oven at the banquet facility use degrees Celsius. She knows that cold foods must be kept below 40°F and hot foods must be kept above 140°F. What will Denise need to know in order to convert from Fahrenheit to Celsius?

## EXPLORE THE MATH

Temperature is measured using thermometers that may be calibrated to different scales. In Canada, temperature is measured using the Celsius scale, but there are some cases where the Fahrenheit scale is also used. What examples can you think of? If you have travelled to the United States, you may have heard temperatures stated in degrees Fahrenheit. The Celsius and Fahrenheit scales are the two scales most commonly used in daily life and in the workplace. For instance, tradespeople who work outdoors have to know the external temperature in order to calculate the setting times of solvents, adhesives, or paint. In what other jobs might you need to measure temperatures?

In the SI, temperatures are measured using the Celsius scale. Because the Celsius system is a 100-step scale from the freezing to the boiling point of water, it is sometimes referred to as centigrade, from the Latin words meaning 100 steps.

## ACTIVITY 4.1
## PREPARE A TEMPERATURE GRAPH

On the Celsius scale 0° is the freezing point of water, while on the Fahrenheit scale, water freezes at 32°. Other equivalencies that exist are shown in the chart below:

**EQUIVALENCIES IN FAHRENHEIT AND CELSIUS UNITS**

| *Example* | *°F* | *°C* |
|---|---|---|
| Bitterly cold day | –22 | –30 |
| Mild day | 59 | 15 |
| Hot day | 81 | 27 |
| Normal body temperature | 98.6 | 37 |
| Boiling water | 212 | 100 |

1. Use the above information to sketch a graph from which you can determine the Fahrenheit temperature that corresponds to any Celsius temperature between 0° and 100°.
2. What type of relationship appears to exist between the two temperature scales?
3. Use the graph to determine the approximate Fahrenheit equivalent for 20°C, 40°C, 60°C, and 80°C.
4. Each pair of Celsius temperatures above differs by 20°C. What do you notice about the differences in Fahrenheit?
5. How can you use the graph to determine the degrees Celsius that correspond to a given Fahrenheit temperature?
6. Use the graph to determine the approximate Celsius equivalent of –10°F.

## ACTIVITY 4.2
## DEVELOP A CONVERSION FORMULA

1. Work with a partner and use the information from Activity 4.1 to estimate the safe temperatures in the Math on the Job on the previous page.
2. Using the fact that 0°C and 100°C are the freezing and boiling points of water respectively on the Celsius scale and that the corresponding temperatures on the Fahrenheit scale are 32°F and 212°F, develop a formula for converting degrees Fahrenheit to degrees Celsius.
3. Use your understanding of equations to adapt this formula so that you can convert directly from degrees Celsius to degrees Fahrenheit.

**HINT**

When substituting a number for a letter in a formula, use brackets around the number, including its sign, so you don't confuse the operation symbol with the number sign.

4. Since one must be very careful in handling food, use the formulas you have developed to determine the exact values for safe storage of food in the Math on the Job. Were your estimates based on the graph close enough?

### Mental Math and Estimation

The thermometer on the outside of your house reads 20°F. Estimate what the temperature would be if expressed in degrees Celsius.

## DISCUSS THE IDEAS

### SEPARATION OF CRUDE OIL

When crude oil is refined, it is heated and separates into different fuels, such as gasoline, kerosene, diesel oil, and fuel oil. As the crude oil is heated, it turns into vapour. When the vapour cools, the different fuels condense at predictable temperatures.

Measurement coordinators are responsible for maintaining temperature records during the oil separation process. Like many tradespeople who convert measurements on a regular basis, measurement coordinators often use a formula containing decimals rather than fractions. Sian is a measurement coordinator at a Saskatchewan oil refinery. She has recently been consulting with a colleague in the US and would like to send him a report about fuel condensation points, giving him the data in degrees Fahrenheit.

These are the temperatures she wants to include:

**FUEL CONDENSATION POINTS**

| *Fuel* | *Condensation point (°C)* |
|---|---|
| Gasoline | 150 |
| Kerosene | 200 |
| Diesel | 300 |
| Fuel oil | 370 |

1. Rewrite the conversion formula $F = \frac{9}{5}C + 32$ using decimals.
2. Convert the four fuel condensation points from Celsius to Fahrenheit using decimals.
3. Use your understanding of equations to solve for $C$ so that Sian can convert directly from Fahrenheit to Celsius.
4. What advantage is there to using decimals rather than fractions in conversion formulas?

### Example 1

Harpreet is transporting frozen food from Los Angeles to Vancouver in a refrigerated truck. The external temperature in Los Angeles is 90°F when he leaves. He knows that the safest temperature for preserving the frozen food is between 0°F and –4°F. When he arrives at the Canadian border, the border guard determines the temperature of the truck to be –19°C. Is this within the acceptable range of temperature for preserving frozen food? Give your answer to the nearest half a degree.

*Harpreet must ensure that his cargo remains frozen or it won't be safe to eat.*

**SOLUTION**

Use the formula for converting degrees Fahrenheit to degrees Celsius.

First, convert –4°F to degrees Celsius.

$$C = \frac{5}{9}(F - 32)$$

$$C = \frac{5}{9}[(-4) - 32] \qquad \text{Substitute } -4 \text{ for } F.$$

$$C = \frac{5}{9}\left(\frac{-36}{1}\right)$$

$$C = \frac{5}{\cancel{9}_{1}} \times \frac{\overset{-4}{\cancel{-36}}}{1} \qquad \text{Simplify.}$$

$$C = 5(-4)$$

$$C = -20$$

Therefore, –4°F is equivalent to –20°C.

Next, change 0°F to degrees Celsius using the same method.

$$C = \frac{5}{9}(F - 32)$$

$$C = \frac{5}{9}[(0) - 32]$$

$$C = \frac{5}{9}\left(\frac{-32}{1}\right)$$

$$C = \frac{-160}{9}$$

$$C \approx -17.78$$

Therefore, 0°F is rounded to –18°C.

The Celsius thermometer should read between –18° and –20°. Since Harpreet's truck is at –19°C, it falls within the safe range.

### *Example 2*

While travelling in the US, Jennifer and Richard are concerned because their daughter Isabella has a temperature of 39°C, so they take her to a medical clinic. The nurse takes Isabella's temperature on the Fahrenheit scale. What will Isabella's temperature be in degrees Fahrenheit?

**SOLUTION**

Use the formula $F = \frac{9}{5}C + 32$ plus your calculator to convert Isabella's temperature.

$F = \frac{9}{5}(39) + 32$ Substitute 39 for $C$.

$F = 102.2$

Isabella has a fever of 102.2°F. Normal body temperature is about 37°C or 98.6°F.

## ACTIVITY 4.3
## COOKING AT HIGHER ALTITUDES

The definitions of freezing and boiling points for water have been established at sea level. Due to differences in atmospheric pressure, these change with altitude. At higher elevations, water will "boil" at a lower temperature but may not be hot enough to make coffee. The pressure difference also affects the preparation of food.

T You and a partner have planned an excursion for a party of eight to Abbot Pass on the British Columbia-Alberta border. You will have breakfast at a hut 2925 metres above sea level. Use the internet to research how you may need to change your breakfast preparations.

1. At what temperature will water boil? Express your answer in degrees Celsius.

2. At sea level, it takes 3 minutes to prepare a soft-boiled egg. How many minutes will it take to prepare a soft-boiled egg at the hut on Abbot Pass?

*Abbot Pass is located in the Rockies between Mount Lefroy and Mount Victoria, shown here.*

## BUILD YOUR SKILLS

1. Cooked meat must reach a recommended internal temperature before it is safe to eat. A cookbook contains a list stated in degrees Fahrenheit.

**FIGURE 4.1**
**Recommended Internal Temperatures**

| *Meat* | *Temperature* |
|---|---|
| ground meats | 160°F |
| beef (medium rare) | 145°F |
| beef (well-done) | 170°F |
| chicken (whole) | 165°F |

Determine the corresponding temperatures in degrees Celsius.

2. Mandy supervises a road construction crew. She knows that she must modify the asphalt paving mixture her crew uses if temperatures drop below 21°C. What is this temperature in degrees Fahrenheit? Why would temperature have an effect on the paving mixture?

*Crews usually pave in the summer because the asphalt needs warm temperatures to set properly.*

3. Chan works at a building construction site. His boss told him that he does not have to work if the temperature is above 105°F or below –15°F. Chan has a Celsius thermometer. What are the limits the boss has stipulated for him in degrees Celsius? Why might Chan's boss state these temperatures? What other factors, other than straight temperature, might affect Chan's and his boss's decision to work on the construction site on a particular day?

4. Pedro purchased a new crimper for his hair salon. The regulations state that the surface temperature, when in use, will be $(230 \pm 10)$°C. What is this in degrees Fahrenheit? Express the answer in the form $(T \pm t)$°C.

5. In the summer, Bev turns on her air conditioner to keep her house cool, but in the winter, she turns on the furnace to warm it up.

   a) Check your thermostat at home to determine the temperature. Be sure to note if it is °C or °F. Convert the temperature to the other scale.

   b) Compare your home's temperature with that of at least 3 other students. What is the range of temperatures in the homes of you and your friends in °C? °F?

   c) If Bev likes to keep the inside temperature between 18°C and 22°C, what would the Fahrenheit temperatures be?

## Extend your thinking

6. Use the conversion formulas to determine the temperature(s) at which degrees Celsius equal degrees Fahrenheit.

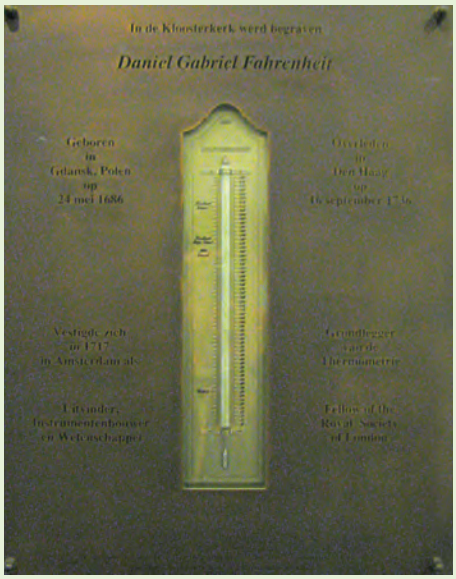
## MEASURING TEMPERATURE

*This is a modern-day thermometer based on Galileo's thermoscope.*

People have intuitively known about temperature—the measurement of heat and cold—since the beginning of time. Fire is hot and ice is cold! People gained more knowledge about temperature as they started working with metals and needed to determine the level of heat required to melt them. However, people's understanding of temperature remained subjective for a long time. The thermoscope was one of the first instruments developed to indicate that one thing was hotter or colder than another. In 1592, the Italian scientist and mathematician Galileo invented an air thermoscope that was very sensitive to changes in temperature, but it was also subject to changes in air pressure. This meant that the thermoscope could indicate when there was a change in temperature, but it could not measure temperature itself. Another Italian scientist, a doctor named Santorio Santorio, is credited with being the first person to apply a number scale to the thermoscope in 1612, thus making the first useful thermometer.

Daniel Gabriel Fahrenheit produced the first alcohol thermometer in 1709 and the first mercury thermometer in 1714 in Amsterdam, Netherlands. In 1724, he wrote an article, introducing his new temperature scale. Although no one is completely sure how Fahrenheit set the scale, it is commonly thought that he set the starting point, or 0°, as the point to which the mercury in the tube descended when it was placed in a mixture of ice and salt, which was the coldest measurable substance at the time. Using a 12-point scale (similar to a foot-long ruler), Fahrenheit set the upper point of the scale at normal body temperature, which he determined was 96°. He then set the thermometer in water that was turning into ice. Fahrenheit determined that the temperature at which the water froze was 32°. Using his scale, Fahrenheit's successors determined the boiling point of water to be 212°. They also made slight changes to his calculations, but they maintained the 12-point scale.

Anders Celsius, from Uppsala, Sweden, is acknowledged to be the inventor of the Celsius scale, although history tells us that he worked with a group of colleagues. The Celsius scale was first used in 1742. Celsius determined that the freezing and boiling points of water depend on atmospheric pressure, and for this scale, he set the freezing point and boiling point of pure water at sea level to be 0° and 100° respectively. In 1954, the 10th Conférence générale des poids et mesures (CGPM) defined these points to be taken at the atmospheric pressure at mean sea level at the latitude of Paris, France because, for practical purposes, this pressure reflects that of many industrialized cities around the world.




*Fahrenheit's burial marker includes an example of his thermometer.*

1. Is a degree the same from one scale to another?
2. How do you think a thermometer works? Why does the liquid in a thermometer rise and fall?
3. Celsius used the boiling and freezing points of water to calibrate his scale. Can you think of other calibration points that could be used? Can you explain why Celsius and Fahrenheit used two points?

# 4.2 Mass in the Imperial System

## MATH *ON THE JOB*

Craig and Genevieve own and manage a pet food store in Saskatoon, Saskatchewan. In order to keep their business profitable, they need a wide range of financial and computer skills. They must also be familiar with all the different products they sell, so they will know which ones to recommend to their customers.

Some of Craig and Genevieve's suppliers are in Canada, but others are in the US. Products ordered from the US are weighed in pounds and ounces. There are 16 ounces in 1 pound. Because many of their customers are elderly and prefer the imperial system of measurement, Craig and Genevieve often package their pet foods in imperial units.


*These dog treats are sold in bulk and priced by the pound.*

Craig and Genevieve purchased 288 pounds of cat food at $2.50 a pound. They plan to sell it to their customers in 12-ounce packages. To cover overhead and to make a profit, they have calculated that they must charge 175% of what they paid. How many packages of cat food will there be and what must they charge for each one, not including taxes?

## EXPLORE THE MATH

**mass:** a measure of the quantity of matter in an object

**weight**: a measure of the force of gravity on an object

Although people often use the terms mass and weight interchangeably, there is a difference between them. **Mass** refers to the quantity of matter in an object. Mass is usually measured using a balance to compare a known amount of matter to an unknown amount of matter. **Weight** is a measure of the force of gravity on an object. Weight is therefore a measurement of the heaviness of a body, the force with which a body is attracted to a celestial body (planet or moon, for example), and is equal to the product of the object's mass and the acceleration of gravity.

But what does this mean? Simply stated, it means that wherever an object is, its mass will remain constant. However, the further away it is from the centre of gravity, the less it will weigh. You may have studied planets in science and know that on another planet, because the force of gravity is different than it is on earth, an object would weigh a different amount. Recall how astronauts in space look the same as they do on earth—they have the same size and shape—but they are weightless! On the moon, you would weigh about $\frac{1}{6}$ of what you weigh on earth.

Measuring weight and mass are necessary tasks for many trades. For example, crane and hoist operators weigh material to determine whether it can be lifted safely and they often use imperial measures.

In the imperial system, the slug is the unit of mass and the pound is the unit of weight. The slug is not often used, and we have come to use the pound as the basic unit for both mass and weight. Although Canada converted from imperial units to SI units in the 1970s, many Canadians measure weight in pounds. Some trades still measure weight in pounds, too, including forklift operators and building contractors.

In the imperial system, there are three commonly used units of weight: the ounce, the pound, and the ton. The pound is the basic unit of weight.

*Crane operators often weigh their loads in imperial units.*

| | |
|---|---|
| 1 ton (tn) = 2000 pounds | A ton is sometimes referred to as a short ton. An adult bison may weigh 1 tn. |
| 1 pound (lb) | A football weighs approximately 1 lb. |
| 16 ounces (oz) = 1 pound | One slice of bread weighs about 1 oz. |

**HINT**

A pound is slightly less than ½ a kilogram. This can be useful when making an estimate or doing a mental calculation.

Pound is abbreviated lb because it comes from the Latin word for pound, *libra*. Ounce is abbreviated oz because it comes from an old Italian word for ounce, *onza*.

In order to define what one pound is, we need a standard with which to compare it. The pound is actually defined in terms of the SI system as the rounded value of 0.453 592 37 kilograms.

## DISCUSS THE IDEAS

### THE WEIGHT OF WASTE

*Recycled material is measured in both cubic yards and pounds.*

Imagine that you work at a waste management plant. You are responsible for managing the process of getting the loose recycled materials that you receive ready for shipping to the companies that actually recycle the materials (for example, that melt glass down so that it can be made into new glass products). You must consider many variables in determining how you will prepare the materials for shipment. One important thing to consider is the volume vs. the weight of the materials in different forms. See Figure 4.2 for some examples.

1. Why would you need to consider the weight and the volume of the materials?

2. What factors would affect the weight of the materials, other than their volume?

**FIGURE 4.2**

**Volume to Weight Conversion Table for Recyclable Materials**

| *Material* | *Volume* | *Estimated weight (pounds)* |
|---|---|---|
| computer paper—uncompacted | 1 cubic yard | 655 |
| computer paper—compacted and baled | 1 cubic yard | 1310 |
| refillable soft drink bottles | 24 bottles | 22 |
| glass bottles—whole | 1 cubic yard | 500–700 |
| glass bottles—crushed | 1 cubic yard | 1800–2700 |
| cans—whole | 1 cubic yard | 150 |
| cans—compacted | 1 cubic yard | 850 |
| finished compost | 1 cubic yard | 600 |
| used motor oil | 1 gallon | 7 |

## ACTIVITY 4.4
## CHOOSING IMPERIAL UNITS

When weighing objects, it is important to think about what units to use. For example, in weighing a load of bricks, you would probably use tons because they are very heavy. A grown person usually weighs him/herself in pounds, whereas a newborn baby's weight is measured in pounds and ounces. Working with a partner, determine 5 objects that you encounter in daily living that would be weighed in ounces, 5 that would be weighed in pounds, and 5 that would be weighed in tons. Justify your choices. Other than a young baby, can you think of objects that might be weighed in pounds *and* ounces?

*Babies are usually measured in pounds and ounces.*

### *Example 1*

Stephan is building a rectangular water cistern on an acreage outside Beausejour, Manitoba so that he can collect rainwater for his garden. The inside dimensions of the finished cistern will be 10 feet 8 inches by 8 feet 4 inches by 4 feet 6 inches. A cubic foot of water weighs about 62 pounds 8 ounces. If the cistern is completely filled with water, what will be the weight of the water expressed in tons?

**SOLUTION**

Since 12 inches equals 1 foot, we can convert the amounts expressed in inches to feet by dividing by 12 and simplifying.

$\frac{8}{12} = \frac{2}{3}$ Eight inches is $\frac{2}{3}$ of a foot.

$\frac{4}{12} = \frac{1}{3}$ Four inches is $\frac{1}{3}$ of a foot.

$\frac{6}{12} = \frac{1}{2}$ Six inches is $\frac{1}{2}$ of a foot.

The dimensions of the cistern can, therefore, be stated as $10\frac{2}{3}$ feet by $8\frac{1}{3}$ feet by $4\frac{1}{2}$ feet.

The volume of a rectangular prism is found by multiplying length times width times height.

$V = l \times w \times h$

Calculate the volume of water in the cistern using this formula.

$$V = 10\frac{2}{3} \times 8\frac{1}{3} \times 4\frac{1}{2}$$

$$V = \frac{32}{3} \times \frac{25}{3} \times \frac{9}{2}$$

$$V = \frac{7200}{18}$$

$V = 400$ cubic feet

If 1 cubic foot weighs 62 pounds 8 ounces, then 400 cubic feet weigh 400 times this amount.

Convert 62 pounds 8 ounces to pounds.

$$\frac{8}{16} = \frac{1}{2} \text{ pound}$$

Water thus weighs $62\frac{1}{2}$ pounds per cubic foot.

Calculate the weight of the water.

$$400 \text{ ft}^3 \times 62\ \frac{1}{2} \text{ lb/ft}^3 = 400 \times \frac{125}{2} \text{ lb}$$

$$400 \times \frac{125}{2} \text{ lb} = 25\ 000 \text{ lb}$$

Convert the number of pounds to tons by dividing by 2000.

$25\ 000 \div 2000 = 12.5$ tons

The weight of the water in the cistern would be $12\frac{1}{2}$ tons.

### *Example 2*

George estimates that each bale of hay in his field weighs 62.5 pounds on average. There are 892 bales to be picked up. If his truck can carry 8 tons on one trip, how many trips will he have to make to move his bales?

*Farmers usually bale hay in the middle of the day, so the hay is not damp from dew.*

**SOLUTION**

Find the total weight of the bales in pounds by multiplying the number of bales by the weight per bale.

$$892 \text{ bales} \times 62.5 \text{ pounds/bale} = 55\,750$$

$$55\,750 \div 2000 = 27.875 \text{ tons}$$

Next, find the number of trips George will need to make.

$$27.875 \div 8 \approx 3.5$$

George will need to make 4 trips.

## Mental Math and Estimation

Annalise works as a fishing guide in the Northwest Territories. On a recent trip, her client caught two chinook salmon. One salmon weighed 20 lb 7 oz and the other weighed 21 lb 9 oz. What is the total weight, in pounds, of the two salmon?

*Annalise's client caught two average size chinook salmon.*

## BUILD YOUR SKILLS

1. Choose the correct item to go with each weight. About how much do you think each of the other items weighs?

   a) About 1 ounce:

   i. pat of butter ii. loaf of bread iii. house cat

   b) About 1 pound:

   i. sofa ii. small basket of raspberries iii. gallon of water

   c) About 1 ton:

   i. refrigerator ii. large dog iii. blue whale

*What unit would you use for the weight of a hippopotamus?*

2. Which unit—ounce, pound, or ton—would you use to express the weight of the following? Give an alternate choice, if suitable, and justify your answer.

   a) brick

   b) plasma TV

   c) box of chocolates

   d) hippopotamus

   e) duck

   f) box of books

   g) tractor-trailer truck

3. At birth, Johan weighed 7 pounds 9 ounces.

   a) Why are newborns' weights given in pounds and ounces and not rounded to the nearest pound?

   b) What would Johan's weight be in ounces?

   c) Why are newborns' weights not given in ounces alone?

   d) Marc, the nurse on the maternity ward, told Dawn that her baby would lose about 10% of his weight in the first week. Then the baby would likely gain about 5 ounces a week for the next four weeks. What should Dawn expect Johan to weigh at 5 weeks of age if he weighed 7 pounds 9 ounces at birth?

   e) How does Johan's weight at 5 weeks compare to his weight at birth?

   f) Would the comparison be different if he had weighed more or less at birth?

4. A contractor is building a patio behind Polli's house. The cement slab will be 9 feet 8 inches long, 7 feet 3 inches wide, and 4 inches thick. If the concrete weighs 150 pounds a cubic foot, what is the weight of the concrete in Polli's patio?

5. Coffee is the second most highly traded commodity in the world. Hon owns a coffee shop. He buys fresh fair-trade coffee beans because he knows that this helps protect the coffee farmer's income. The beans he buys weigh 35 pounds a cubic foot, and after he roasts them, they weigh only 27 pounds a cubic foot. He sells his coffee for $17.95 a pound.

a) What do you think is the most highly traded commodity in the world?

b) Assume that the farmer selling the beans got a market floor price of $1.35 a pound. If Hon buys 25 cubic feet of coffee beans, and sells it at $17.95 a pound after roasting, compare the income of the farmer with Hon's selling price.

*Coffee beans are lighter after roasting because they lose moisture during the process.*

## Extend your thinking

6. Think about question 5 above.

   a) Do you think the farmer received a fair price? Why or why not?

   b) Do you think Hon paid $1.35/lb for the beans? Why or why not?

7. Pete can carry a maximum of 8 tons in his truck. He has been hired by the waste management plant that he works for to transport 105 cubic yards of compacted computer paper to be recycled. Sam measures the box of Pete's truck and notes that it will hold 24 cubic yards. He therefore reasons that Pete will need to make 4.375 trips, after dividing 105 $yd^3$ by 24 $yd^3$. Explain what is wrong with Sam's reasoning and determine the correct number of trips Pete will need to make.

# 4.3 Mass in the Système International

## MATH *ON THE JOB*

Jeff and Winona work as emergency medical professionals in Whitehorse, Yukon. In an emergency, they are often the first on the scene.

Jeff and Winona completed a Primary Care program approved by the Canadian Medical Association. This program included courses on basic anatomy and vital statistics, legal and ethical behaviour, how to deal with trauma, and even proper vehicle operation.

*Jeff and Winona must know their patient's weight to calculate the correct dose of medicine to administer.*

When responding to an emergency situation, Jeff and Winona may need to administer a treatment or drug based on presented conditions and treatment charts. For example, if a patient is thought to have suffered a cardiac arrest (heart attack), Jeff or Winona would usually administer an appropriate drug. The recommended concentration of one such drug is 1:10 000 and its recommended dosage is 0.01 to 0.03 mg/kg of a person's weight.

Jeff and Winona respond to a 911 call. The symptoms of the 52-year-old patient indicate a cardiac arrest. His wife tells them that her husband weighs about 70 kg. Use proportional reasoning to calculate the acceptable dosage of this drug for Jeff and Winona to administer.

## EXPLORE THE MATH

**kilogram:** the mass of one litre of water at 4°C

In the last section, you discussed the differences between mass and weight and determined that in the imperial system, we tend to use the term pound—a unit of weight—for both mass and weight. In the SI units, we do the opposite. The correct term for a unit of weight is the newton, but we use the term **kilogram**, a unit of mass, to refer to both mass and weight.

### ACTIVITY 4.5
### USING SI PREFIXES

Since the kilogram is the basic unit of mass in the SI system, use your understanding of the prefixes you know to determine:

1. the number of grams in a kilogram
2. the name for 1000 kilograms
3. the name for $\frac{1}{1000}$ of a gram

## ACTIVITY 4.6
## EQUIVALENT MASSES

Work with a partner to discuss the following two situations. Write a justification of your solutions. The megagram is generally referred to as a **tonne**, a metric ton, or a long ton.

**tonne**: a metric ton; 1000 kilograms

1. Use your understanding of weights to determine a referent for:

   a) 1 tonne (t)

   b) 1 kilogram (kg)

   c) 1 gram (g)

   d) 1 milligram (mg)

2. 2.8 t, 2800 kg, and 2 800 000 g are equivalent masses. Each represents the mass of a truck. Which would be the most appropriate unit to use if you were discussing the mass of a truck? Why?

*It would be unusual to give a truck's weight in grams.*

3. When you are cooking, there is more than one way to determine how much of an ingredient to use. Some recipes give amounts in volume and others use mass, especially those from Europe. If you use a measuring cup, you are measuring volume. To measure mass, you need a kitchen scale.

   You are measuring the amount of flour you need to make a cake, but some of your batter has splashed on your recipe and hidden the unit of measurement. You can see that the number is 250. Would this be tonnes, kilograms, grams, or milligrams? Give examples of items that might weigh each of these amounts. Do not use the referents suggested above.

### *Example 1*

You and your 5 friends want to use your motorboat to cross the bay and you are the only one who can pilot the boat. The maximum capacity for your boat is listed as 0.55 tonnes. You weigh 75 kg and your friends weigh 76 kg, 82 kg, 63 kg, 68 kg, and 78 kg respectively. You also have 104 kg of supplies. How many trips will you have to make in order for everyone (and your supplies) to get across the water safely? Give reasons for your answer.

**SOLUTION**

Convert 0.55 tonnes to 550 kg. This is the maximum load for your motorboat. Find the total weight of you, your friends, and the supplies.

$$75 + 76 + 82 + 63 + 68 + 78 + 104 = 546 \text{ kg}$$

Strictly speaking, your boat has the capacity to carry the total weight in one trip. However, since the weight is so close to the capacity limit, you might consider making two trips because your clothes weigh something, the water might be rough, and so on.

## DISCUSS THE IDEAS

### GROSS VEHICLE WEIGHT RATING

Truckers and others who transport loads in their vehicles need to be aware of their Gross Vehicle Weight Rating (GVWR). The GVWR is the maximum recommended weight of a vehicle, including everything it is carrying: the vehicle itself, cargo, passengers, other accessories, and fuel. The base curb weight is the weight of the vehicle with a full tank of fuel. The difference between these two weights is the cargo capacity.

You and your friend rent a truck with a 3016 kg GVWR and a base curb weight of 2255 kg, so that you can help your friend haul a load of bricks for a construction project. The combined weight of you, your friend, and your accessories is 160 kg. If one brick weighs 2.7 kg, how many bricks can your truck carry?

## ACTIVITY 4.7
## PROTEIN VS FAT CONTENT

Your health food store carries several different brands of nutritional bars. The bars come in different sizes and they have different proportions of nutrients. A woman between the ages of 19 and 30 requires about 0.8 grams of protein per kilogram of weight and about 48 grams of fat every day.

A 24-year-old who weighs 55 kg tells you she would like to get her daily required intake of protein from nutritional bars, but she is worried about the amount of fat in them.

1. How many grams of protein does she need each day?

2. Using at least 3 different types of nutritional bars, determine how many bars of each type she would have to eat in a day to get her allotted amount of protein and how much fat she would consume. Record your findings on a table like the one that follows.

**NUTRITIONAL BAR PROTEIN AND FAT CONTENT**

| *Type of bar* | *Grams of protein per bar* | *Grams of fat per bar* | *Number of bars needed for protein* | *Total amount of fat in bars* |
|---|---|---|---|---|
| NG | 2 | 3.4 | | |
| EM | 15 | 4.5 | | |
| LT | 15 | 11.1 | | |
| | | | | |



3. Based on your findings, which bar would you advise your client to buy?

## ACTIVITY 4.8
## ESTIMATING MASS

Every day we have to estimate the weight of objects. Choose an object you use fairly regularly that you think weighs approximately 1 kilogram. This object will be your referent for weight.

1. Using your referent for comparison, find objects with the following estimated weights:

   a) 2 kg

   b) 5 kg

2. Use a balance to determine the actual weight of your referent. Was it more or less than 1 kg? As a result, do the objects you chose weigh more or less than your estimate?

3. Would this method of estimation be a good way to estimate the weight of a heavy object? Why or why not?

## DISCUSS THE IDEAS

### MASS/WEIGHT CONVERSION BETWEEN IMPERIAL AND SI

There are many important conversion factors that you use daily. For example, earlier you used a conversion formula to convert degrees Celsius to degrees Fahrenheit and vice versa. You also explored conversions in chapter 3. Think about the relationship between pounds and kilograms.

1. In Europe, the term "pound" is often used to mean half a kilogram. Is this an appropriate use of the term? Why or why not? Use your understanding of pound and kilogram to discuss the relationship between them. List three items you sometimes hear talked about in pounds.

*Some of these items are measured in grams, some in kilograms, and others in tonnes.*

2. Stores sometimes list prices of vegetables by both the pound and by the kilogram. If they only gave the price per pound, how would you determine the price per kilogram? Explain your reasoning.

3. Sometimes the price for items is listed as dollars per 100 grams.

   a) Why would the store price items this way rather than per kilogram?

   b) What types of items would likely be priced in this way?

4. A bag of sand is labelled as 20 kg and also as 44 lb. Use this information to develop a conversion formula from kilogram to pound and pound to kilogram (round to the nearest tenth).

5. Research the approved use of the various units of weights permitted in Canada on the internet.

### Mental Math and Estimation

What is the approximate weight of:

a) a 5 pound roast, expressed in kilograms?

b) a 62 kg person, expressed in pounds?

## BUILD YOUR SKILLS

1. Choose the correct item to go with each measure of mass.

   a) About 1 gram

      i. a brick  ii. a penny  iii. a book

   b) About 1 kilogram

      i. this textbook  ii. a dime  iii. an MP3 player

   c) About 1 gram

      i. a thumbtack  ii. a cat  iii. a chair

   d) About 1 tonne

      i. a bull  ii. two men  iii. a laptop computer

2. Read each statement and judge whether the estimate makes sense. If you disagree with the statement, justify your solution by estimating the approximate weight of the object.

   a) A loaded truck has a mass of about 500 kg.

   b) A small boy has a mass of about 100 g.

   c) A hockey puck has a mass of about 2 kg.

   d) A headache tablet has a mass of 1 mg.

   e) Two loaves of bread have a mass of about 1 kg.

   f) A piece of gum has a mass of about 1 g.

   g) A two-tonne truck weighs about 2200 pounds.

   h) A five-pound roast weighs about the same as a 5 kg roast.

3. Drugs come in different strengths, so the doctor decides what dosage to give you based on your symptoms, age, and weight. The drug penicillin V has a strength of 250 mg per pill, and you have been prescribed a dosage of 0.5 g three times a day for five days.

   a) How many pills will you have to take at one time?

   b) How many milligrams of the drug will you take over the five days?

   c) How many kilograms of the drug is this amount?

4. A gardener wants to mix his own fertilizer so that the strength is 6-7-5. This means that 6% of each tonne is nitrogen, 7% is phosphorus, and 5% is potassium. How many kilograms of nitrogen, phosphorus, and potassium will there be if he mixes 0.5 tonnes of fertilizer?

5. It is estimated that the air in a glass tank weighs 1.29 g a litre. The tank is 2.5 metres by 3.4 metres by 4.1 metres. What is the weight of the air in the tank?

**HINT**

1 litre equals 1000 $cm^3$.

6. You have a recipe for a cheese dip that calls for $1\frac{1}{4}$ lb of Stilton cheese. The store has packages that weigh 253 g, 421 g, 97 g, 398 g, and 124 g. Which packages will you purchase so that you have enough Stilton at the lowest cost?

7. Max must transport 20 sheets of drywall and 480 six-inch by six-inch tiles to a building site. He knows that the drywall weighs 1.7 lbs a square foot, and each sheet is 4 feet by 8 feet. The tiles weigh 2.4 pounds a square foot. What is the total weight of his load, expressed in kilograms?

*Astronauts weigh 83.5% less on the moon than they do on earth.*

## Extend your thinking

8. In 1969, Neil Armstrong became the first person to walk on the moon. His crewmates were Buzz Aldrin, who also walked on the moon, and Michael Collins, who remained in the spacecraft.

   The three astronauts had the same mass on the moon as they had on earth, but they weighed less. The weight you feel on a different planet or moon is affected by the mass of the planet or moon, how far you are from its centre, and your own mass. The greater the mass of the planet, the more you will weigh.

   Use your knowledge of the planets to judge:

   a) on which planet you will weigh the most;

   b) on which planet you will weigh the least.

T Use the internet to determine your weight on the planets where you weigh the most and the least, and calculate a conversion factor.

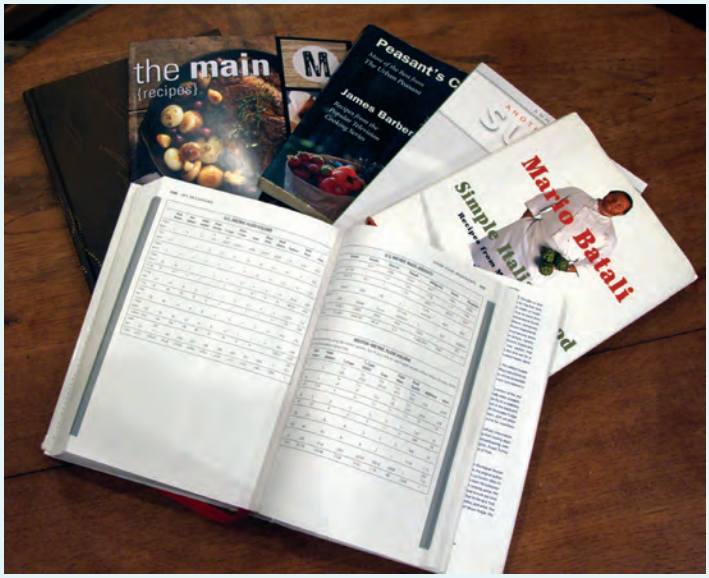
## PUZZLE IT OUT

### THE COUNTERFEIT COIN

You have 12 golden coins that look identical, but one of them is counterfeit. Using a balance, and at the most 3 weighings, how can you determine which coin is counterfeit?

*You can use a balance to compare the mass of two objects.*

## CREATE CONVERSION TABLES




*Many cookbooks contain conversion charts for common ingredients.*

Now that you have created your menu and decided on your recipes, you can begin work on the other components of your recipe book.

You may have noticed that many recipe books include conversion charts for common ingredients. In your booklet, you will create a conversion chart for your ingredients.

First, write a list of all the ingredients that your recipes require. Next, choose a standard unit of measurement (100 grams, for example) on which to base your conversions. Finally, make a chart and complete it for each ingredient. You will have to calculate the amounts in SI and imperial units for mass and volume for each ingredient.

T Note that when converting between weight and volume, the conversion will not be the same for every ingredient. For example, one cup of flour will weigh a different amount than one cup of sugar. Use the internet or other resources to find the volume and weight equivalencies for your different ingredients. If using the internet, you may want to check a couple of different websites to make sure that what you find is accurate.

After you have listed your ingredients and determined equivalent conversion amounts for each one, convert the amount of each that your recipes require. Complete a table showing the amounts given by your recipe, then perform the conversions into the other units of this amount. This will serve as a shopping list for anyone who would like to make the dishes in your menu.

You now have two tables for your recipe booklet.

# 4.4 Making Conversions

## MATH *ON THE JOB*

Louise Niwa is the operations manager for a family business, Niwa Ranching Company, in Acadia Valley, Alberta. She completed a science program at the University of Saskatchewan in 2000 and worked in feed formulation/nutrition at a feed mill before moving back to the farm. "For my science degree, I was required to take some math courses. Now that I am back on the farm, it seems that I use a lot of basic algebra. And conversions are vital to our operations!"

*As the operations manager of Niwa Ranching Company, Louise uses algebra and conversion calculations on a regular basis.*

Jim purchased some rolled barley from the Niwa Ranching Company to feed his cattle. Rolled barley is barley that is processed to make it more digestable. The price of barley at the time was $3.60/bushel plus $0.22/bushel for rolling and delivery. GST of 5% is added to the rolling and delivery charge, but not to the barley. The barley was rolled out of a grain bin directly into a 3-tonne truck. One tonne of barley contains 45.9 bushels. The mass of the full truck was 12 100 kg. The mass of the empty truck was 5550 kg. How much must Jim pay the Niwa Ranching Company for his rolled barley?

## EXPLORE THE MATH

In the past, you have converted from one unit into another, either within a measuring system or between the imperial and SI systems. In the Math on the Job above, a different type of conversion occurred. Grain is measured and sold in bushels, a volume measure, even though the SI measurement for grain in Canada, the tonne, is a measure of mass or weight. A bushel is a unit of volume or capacity equivalent to approximately 2220 cubic inches. The word bushel comes from a fourteenth-century word, *buschel* or *busschel*, meaning box.

In order to solve this problem, you needed to know the conversion factor to convert tonnes of barley to bushels of barley. Since grains weigh different amounts per bushel, a farmer needs to know the correct conversion factor for the grain he is buying or selling. Fortunately, many of these factors have been worked out for you and are available on the internet or in reference books.

## DISCUSS THE IDEAS

### AGRICULTURAL CONVERSION FACTORS

In the Math on the Job problem at the beginning of this section, you needed the conversion factor of 45.9 bushels per tonne of barley to help Jim determine how much to pay for the barley. Farmers grow many other types of grain, such as wheat, flax, oats, and mustard. A different conversion factor is needed for each type of grain. Why do you think this is the case? Search the internet to find conversion factors for these other grains.

Using your experience in daily life, think of other times when you make conversions that are between volume and weight. List as many as you can and determine the conversion factor if possible. When might it be more appropriate to use volume? When would you use weight?

*Barley is just one of the many grains farmers grow in Canada.*

## ACTIVITY 4.9
## USING CONVERSION FACTORS

The Niwa Ranching Company has an old rectangular wooden bin in which Louise stores grain. To calculate the crop insurance she needs, she must determine the volume of oats the bin holds. Louise measured the bin and determined that it was 15 feet long by 12 feet wide by 9 feet high.

1. How many bushels of oats will the bin hold?
2. For transporting the grain, Louise needs to know the weight of the oats. How many tonnes are in the bin?

Work with a partner to solve this problem. See if you can find at least two different approaches.

### *Example 1*

Rain is catering a dinner for 20 people. She consults a cookbook that tells her she will need approximately $\frac{3}{4}$ lb of beef for each person and that it will take approximately 20 minutes per pound to cook at 350°F.

a) Approximately how many kilograms of beef should Rain buy?

b) At what approximate temperature Celsius should she cook it?

c) Approximately how many minutes per kilogram will she have to cook the roast?

**HINT**

Remember that 1 kg is equal to about 2.2 lb.

*Rain must calculate the cooking time and temperature for her roast beef.*

**SOLUTION**

a) Determine how many pounds of beef Rain needs to buy.

$\frac{3}{4}$ lb/person × 20 = 15 lb

2.2 lb are approximately 1 kg. Find the number of kilograms by dividing 15 pounds by 2.2.

$$\frac{15}{2.2} = 6.82$$

Rain should buy a roast that is almost 7 kg.

b) Convert 350°F to degrees Celsius.

$C = \frac{5}{9}(F - 32)$ Use the formula for converting Fahrenheit to Celsius.

$C = \frac{5}{9}(350 - 32)$

$C = \frac{5}{9}(318)$

$C = \frac{1590}{9}$

$C = 176.7$

The oven temperature will be 176.7°C, rounded to 180°C.

c) To estimate the minutes per kilogram Rain will have to cook the roast, use the conversion estimate 1 kg = 2.2 lb.

$\frac{20 \text{ min}}{1 \text{ lb}} = \frac{x \text{ min}}{2.2 \text{ lb}}$ Set up a proportion.

$(2.2)\frac{20}{1} = \frac{x}{2.2}(2.2)$ Multiply by 2.2 to isolate the variable.

$2.2 \times 20 = x$

$44 = x$

It will take approximately 44 minutes per kilogram to cook the roast.

**ALTERNATIVE SOLUTION**

a) Find out how many kg/person is required by dividing $\frac{3}{4}$ or 0.75 by 2.2, then multiplying this by 20 people.

$0.75 \div 2.2 = 0.34$

$0.34 \times 20 = 6.8$ kg

## ACTIVITY 4.10
## HOW MUCH CAN A FORKLIFT LIFT?

You work for a construction company that is about to embark on a new project. Your task is to source 4 forklifts for the job. You have been asked to research and present several classes of forklifts with information on how much weight they can lift. Your findings will be distributed to the project managers, and they have requested that the lift information be supplied in tons, metric tonnes, pounds, and kilograms—so you may need to do some conversions. You should also indicate whether the forklift is intended for indoor or outdoor use. Use the internet to research forklifts and complete a table like the sample below.

*This forklift is used outdoors for moderate loads of construction material.*

**FORKLIFT MAXIMUM LOAD LIMIT RESEARCH**

| *Forklift brand and model name* | *tons* | *tonnes* | *pounds* | *kilograms* |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

SAMPLE

What other things might you want to consider when purchasing a forklift?

## BUILD YOUR SKILLS

1. A box of baseballs arrives at Vinny's sporting goods store. The box of balls weighs 266 oz and there are 50 baseballs in the box. Vinny discards the box, which weighed 1 pound. What is the weight of each baseball in grams?

2. In her restaurant, Hana uses 25 lb of sugar each day. She asks Raj, her stock clerk, to order enough for the month of January. The sugar comes in 10 kg bags. How many bags of sugar must Raj order to be sure they have enough?

3. Hong is a building contractor. The building code in his area requires that roofs be built to withstand 30 pounds of weight per square foot of horizontal area.

   a) How many kilograms per square metre is this?

   b) After a snowfall, a square foot of flat roof covered with snow has a weight of 18.1 pounds pressing on it. If the flat area of the roof of a house is 1700 square feet, what is the weight of the snow on the roof:

      i. in pounds? ii. in kilograms?

4. Krystina is stacking flats of 355 mL bottles of water on a shelf. If there are 24 bottles in a flat, how much will 12 flats weigh? Ignore the weight of the plastic bottles and the cardboard flat.

   a) in kilograms?

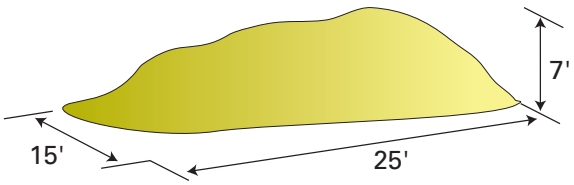
   b) in pounds?

5. Craig and Genevieve have purchased 26 cases of birdseed. Each case contains 16 boxes that weigh 20 ounces each. How much do the 26 cases weigh:

   a) in pounds?

   b) in kilograms?

6. The conversion factor for changing cubic metres of wheat to tonnes is 0.778. Frank has been told that he can estimate the volume of grain dumped on the ground by using the formula $V = l \times w \times h \times 0.5$. If the length of the pile is 25 feet, the width is 15 feet, and the height is approximately 7 feet, how many bushels of wheat are in the pile? (See diagram; 1 tonne of wheat contains approximately 36.744 bushels.)




7. Jason is having a new elevator installed in the four-storey apartment building he manages. Although many people will use the stairs, he knows that at times 5 or 6 people will be on the elevator, and more importantly, it will be used to move furniture. He estimates that the heaviest piece of furniture that people will move will be an upright grand piano. He has checked with movers and has found that pianos can weigh up to 545 kg. He assumes that two strong people would be needed to move a piano and they would ride with it in the elevator. To be on the safe side, Jason estimates that they will weigh about 90 kg each. The elevators he is considering have ratings of no more than 1000, 2000, 3000, 4000, 5000, or 6000 pounds. What is the lowest-rated elevator that Jason should install?

## Extend your thinking

8. A recent trend is for people to purchase goods and foods produced locally and when possible directly from the producer—often limiting themselves to a 100 km radius. This may mean that they have to buy larger quantities at one time. For example, they may buy beef by the "side" directly from a rancher, although the meat must still be properly processed by a licensed butcher. However, a side of beef is a lot of meat and so people sometimes share a side between two or three families.

   Arduk and his family shared a side of beef with two other families. Their share was:

   48 lb of ground beef

   7 lb 9 oz chuck roast

   6 lb 12 oz sirloin roast

   9 lb 14 oz grilling steak

   7 lb 4 oz T-bone steak

   4 lb stewing meat


*Even if you live in an urban area, you can buy locally grown produce at markets like The Forks in Winnipeg.*

   The cost of the meat was $1.75/lb; cutting and wrapping cost an additional $0.42/lb.

   a) How much did Arduk pay for the meat?

   b) What was his cost per kilogram including cutting and wrapping?

   c) How many kilograms (to the nearest tenth) of each type of meat did Arduk buy?

   d) Check the prices of similar cuts of meat at your local grocery store or butcher. How much would you pay for the same amount of meat at the store? Did Arduk save money compared to buying at the local store?

   e) What are some other direct-buy products that you could buy in your neighbourhood?

   f) What reasons, other than cost, might people have for choosing to purchase their beef or other goods directly from the producer?

## COMPILE YOUR WORK AND PREPARE A PRESENTATION

*Adding pictures will make your booklet more attractive.*

You should now have the following information for your project:

- a menu
- a recipe for each dish
- a conversion table for your ingredients
- a table that lists all of your ingredients with amounts

Design your menu. Be creative! Next, compile the last three items in the above list into a booklet that is both attractive and useable. You may want to look at a variety of cookbooks first to get some ideas for the layout. Will you include pictures? How will you organize the elements in your booklet? What page size will you use, and how many pages will your booklet have? Include your converted ingredient amounts with your recipes, not just in the table. Also, be sure to provide conversions for any cooking temperatures that are given in the recipes.

Once you have completed and printed a copy of your menu and your booklet, it is time to start the judging. Evaluate your classmates' menus and booklets according to the judging criteria. May the best menu win!

## REFLECT ON YOUR LEARNING

### MASS, TEMPERATURE, AND VOLUME

Now that you have finished this chapter, you should be able to

- ❒ understand the difference between the Celsius and the Fahrenheit temperature scales;
- ❒ convert from degrees Celsius to degrees Fahrenheit and vice versa;
- ❒ understand the difference between mass and weight and understand why we often use the terms interchangeably;
- ❒ calculate mass and weight in both the SI and the imperial systems;
- ❒ convert mass and weight within each system and between systems;
- ❒ use conversion factors to convert between volume and mass.

In addition, you have completed a project that applied your new skills in a practical context.

## PRACTISE YOUR NEW SKILLS

1. Canada's prairie provinces are known for their extreme temperatures—hot summers and cold winters. Midale and neighbouring Yellow Grass, both in Saskatchewan, recorded Canada's record high temperature on July 5, 1937. It was 113°F. The previous year, on February 16, Midale recorded its lowest ever temperature at –55°F. What would these temperatures have been in degrees Celsius? What do you notice about the differences in these temperatures?

2. The coldest temperature ever recorded in Canada was in Snag, Yukon on February 3, 1947. It was officially recorded as –63°C. What is this in degrees Fahrenheit?

3. Your mother has asked you to water some plants and she has given you a 5-US gallon pail of water.

   a) By first converting US gallons to litres, use your knowledge about the weight of 1 litre of water to determine the weight of a 5-US gallon pail of water. Refer to p. 127 for the volume conversion factor.

   b) How much would 1 $m^3$ of water weigh?

4. Your school has been running a nickel drive to raise money for a sister school in Africa. A nickel weighs approximately 5 g. A roll of nickels is worth $2.00. You have collected a total of $135.65 in nickels.

   a) How much will your nickels weigh?

   b) What is the weight of a roll of nickels?

   c) How many rolls would you need to make 1 kg?

5. A carpenter is installing a floor in an upper room of a house. He is debating whether to install cherrywood, which weighs 35 pounds a cubic foot, or cork, which weighs 15 pounds a cubic foot. If the area of the floor is 180 square feet and the flooring is $\frac{1}{2}$-inch thick, what is the difference between the weight of the cherrywood floor and the weight of the cork floor?

6. A drugstore buys bleach by the skid. Each skid weighs approximately 46.3 lb and holds 48 cases of bleach. Each case contains six 5.38-litre bottles. If one litre of bleach weighs about 847.5 grams, what is the weight of a loaded skid of bleach stated in kilograms? In pounds?

*Wild rice is actually a cereal grain.*

7. Many farmers use anhydrous ammonia to fertilize their crops. Anhydrous ammonia is a chemical composed of hydrogen and ammonia. It contains 82% nitrogen by weight. It is potentially a very hazardous chemical and must be handled appropriately. If the desired rate of application is 100 lb of nitrogen per acre, how many tonnes of anhydrous ammonia must a farmer order to fertilize 860 acres?

8. You are at a worksite and need to determine the weight of the rocks that you will use to finish the front entrance of the house. You do not have a scale, but you have a number of bags of cement that weigh 20 kg each. Explain how you could use them to determine the weight of the rocks.

9. Wild rice is a traditional food of many Aboriginal peoples of western Canada. Today, wild rice is grown and harvested in a number or places, including in numerous northern lakes in Saskatchewan. After the rice is harvested, it is dried, heated, and the hulls are removed before it is packaged and sold. Northern Lights Foods is a company owned and operated by the Lac La Ronge Indian Band that sells certified organic wild rice to the United States, Japan, and European markets.

    a) If the average annual production of wild rice in Saskatchewan is 2.5 million pounds and Aboriginal producers are responsible for one-third of the province's annual crop, how many kilograms of wild rice do Aboriginal harvesters produce?

    b) If there are 25 lb of processed wild rice in a US bushel and Northern Lights Foods sells 8500 lb to a customer in Hawaii, how many cubic feet of rice are they shipping? One bushel contains 1.24 $ft^3$.

    c) If a wild rice harvester sells 600 kg of green rice to Northern Lights Foods and they process it and sell it to a customer in Florida, how many pounds of processed rice will they ship if 10 lb of raw green rice yield 5 lb of processed rice?

## Extend your thinking

10. Jean-Luc decided to make tourtière for his mother for Mother's Day from his grandmother's old recipe. His mother loved this "secret" family recipe and how each ingredient was in perfect proportion with the others. He assembled the ingredients on the counter and, realizing that he did not have the thyme, asked his sister Lucie to carefully measure and mix the other filling ingredients while he popped out to the store. Lucie looked at the recipe and figured it would be simple.

| **TOURTIÈRE** |
| --- |
| 18 oz ground beef |
| 20 oz ground pork |
| 8 oz potatoes, boiled and mashed |
| 6 oz of onion, finely chopped |
| large pinch of thyme |
| pastry for double pie crust |

But Lucie got a little bit confused. She put 18 oz of pork and 20 oz of beef into the bowl, instead of the other way around. She also mixed up the potatoes and onion, using 8 oz of onion and 6 oz of potatoes. Then she mixed all the ingredients together. Luckily, she noticed her mistake. But it is difficult to un-mix.

So now she has to get the recipe back to its proper proportions. And she hopes that the filling will still fit into the crust! What is the smallest quantity of whatever has to be added to get the recipe back to its original proportions?

*Tourtière is a French-Canadian food traditionally served at Christmas.*